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For: Noise Filter, Outdoor Unit and Air Conditioner

VERIFICATION OF TRANSLATION

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2) that I translated the above-identified application from Japanese to English;

3) that the attached English translation is a true and correct translation of the above-identified application to the best of my knowledge and belief; and

4) that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: June 4. 2004 Signature: Hideya Ueki

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SPECIFICATION

NOISE FILTER, OUTDOOR UNIT AND AIR CONDITIONER

TECHNICAL FIELD

The present invention relates to a noise filter, an outdoor unit and an air conditioner and, more particularly, to a noise filter for eliminating noise generated from a predetermined noise generating source in a first unit in an electric device in which power is supplied from an original power source to a second unit via the first unit, an outdoor unit and an air conditioner.

BACKGROUND ART

FIG. 4 is a block diagram showing an example of a conventional air conditioner 1. In the air conditioner 1 of this type, power is supplied from an original power source 2 on the outside to an outdoor unit 3 and, in addition, the power is branched in the outdoor unit 3 and supplied also to an indoor unit 4.

In this case, the power supply from the original power source 2 to the outdoor unit 3 and the power supply branched from the outdoor unit 3 to the indoor unit 4 are performed via respectively separated power source lines 5a, 5b, 6a and 6b.

Reference numeral 7 denotes a signal line and, a bundle of electric lines obtained by bundling the signal line 7 and the power source lines 6a and 6b is called indoor/outdoor lines Lin. Reference numeral 9 indicates a noise generating source such as an inverter or the like in the outdoor unit 3

and reference numerals 10 and 11 denote a transmission circuit and a reception circuit in the outdoor unit 3. The transmission circuit 10 and the reception circuit 11 are connected to the power source lines 5a and 5b via power source lines 8a and 8b and, while receiving the supply of power, transmit/receive signals to/from the indoor unit 4 via the signal line 7. The power source lines 8a and 8b for supplying the power to the transmission circuit 10 and reception circuit 11 are branched and connected to the power source lines 6a and 6b of the indoor/outdoor lines Lin and supply power also to the indoor unit 4.

In the air conditioner 1, the noise generating source 9 exists as described above. Generally, it is requested to design the voltage level of each of noise 12 which is superposed in the power source lines 5a and 5b and noise 13 which is superposed in the power source lines 6a and 6b so as to be within a predetermined specification.

Conventionally, a first noise filter 15 is provided for the power source lines 5a and 5b extending between electrical parts in the outdoor unit 3 such as the noise generating source 9, transmission circuit 10, and reception circuit 11 and the original power source 2 and, a second noise filter 16 different from the first noise filter 15 is provided for the indoor/outdoor lines Lin extending between the electrical parts 9, 10 and 11 and the indoor unit 4.

As described above, when the different noise filters 15 and 16 are provided for the power source lines 5a and 5b between the original power source 2 and the outdoor unit 3 and for the indoor/outdoor lines Lin between the outdoor unit 3 and the indoor unit 4, a problem occurs such that even

when the noise filters 15 and 16 independently try to eliminate the noises 12 and 13, the noise filters 15 and 16 cannot sufficiently eliminate the noises 12 and 13, respectively, due to insufficient properties of the noise filters 15 and 16 and the like.

DISCLOSURE OF THE INVENTION

An object of the present invention is to solve the problem as described above and to provide a noise filter capable of efficiently eliminating noise which generates in an outdoor unit in an air conditioner having a configuration that power is supplied from an original power source to the outdoor unit and the power is branched in the outdoor unit and supplied to an indoor unit, an outdoor unit and an air conditioner.

A first aspect of a noise filter according to the present invention is a noise filter (21) in an electric device for reducing noises (12, 13) from a predetermined noise generating source (9), the electric device comprising a first unit (3) to which power is supplied from an original power source (2) and has the predetermined noise generating source (9), and a second unit (4) to which the power is supplied through a branch in the first unit, wherein power source lines (5a, 5b) for supplying the power from the original power source to the predetermined noise generating source (9) and inter-unit lines (6a, 6b, 7) for supplying the power from the branch to the second unit are wound around the same magnetic body.

Since a choke coil is constructed by winding the power source lines and the inter-unit lines around a common magnetic body, noises can be efficiently eliminated by making the noises in the lines cancel out each

other.

Desirably, the number of turns of the power source lines and that of the inter-unit lines are set to be different from each other.

Since the number of turns of the power source lines and that of the inter-unit lines are set to be different from each other, the ratio of the number of turns of the inter-unit lines to the number of turns of the power source lines may be set on the basis of (for example, almost proportional to) the ratio of an impedance of the inter-unit lines to an impedance of the power source lines. Thus, influences on the magnetic fields of the lines can be made uniform and noises in the lines can be canceled out. Therefore, at the time of eliminating noises, the noises can be prevented from being excessively or insufficiently canceled out.

In the case where the inter-unit lines are constructed of a plurality of lines, for example, a total impedance of the plurality of lines may be regarded as an impedance of the inter-unit lines, and a bundle of electric lines obtained by bundling the plurality of lines may be wound as the inter-unit lines. Alternately, the ratio of the number of turns of the power source lines and the number of turns of the plurality of lines of the inter-unit lines may be set on the basis of (for example, almost proportional to) the ratio of the impedances. In such a manner, noises can be canceled out in balance.

When the present invention is applied to an air conditioner comprising an outdoor unit in the air conditioner as the first unit and an indoor unit as the second unit, noises which generate in a noise generating source in the outdoor unit and fail to be transmitted to an original power

source and an indoor unit can be efficiently eliminated. The present invention is, particularly, effective to the case where an inverter provided for the outdoor unit of the air conditioner is the noise generating source.

The objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing an air conditioner in which a noise filter according to an embodiment of the present invention is installed.

FIG. 2 is a perspective view showing the noise filter according to the embodiment of the present invention.

FIG. 3 is an equivalent circuit diagram showing the noise filter according to the embodiment of the present invention.

FIG. 4 is a block diagram showing a conventional air conditioner.

BEST MODE FOR CARRYING OUT THE INVENTION

FIG. 1 is a block diagram showing an air conditioner in which a noise filter according to an embodiment of the present invention is assembled. In the embodiment, elements having the same function as that of the conventional elements are given the same reference numerals.

The air conditioner has, as shown in FIG. 1, a noise eliminating unit (noise filter) 21 commonly provided for the power source lines 5a and 5b between the original power source 2 and the outdoor unit (first unit) 3 and the indoor/outdoor lines (inter-unit lines) Lin between the outdoor unit 3 and

the indoor unit (second unit) 4 (a bundle of electric lines obtained by bundling the power source lines 6a and 6b and the signal line 7). The noise eliminating unit 21 is formed by, as shown in FIG. 2, winding the power source lines 5a and 5b together with the power source lines 6a and 6b and the signal line 7 in the indoor/outdoor lines Lin around a magnetic body 22 such as a single, annular-shaped ferrite core in a common mode to form a choke coil. Since magnetic fluxes are generated in the directions opposite to each other by the noises 12 and 13 which are respectively transmitted in the power source lines 5a and 5b and in the power source lines 6a and 6b, the noises 12 and 13 can be efficiently eliminated. Therefore, the influence of the noise on the signal line 7 can be also eliminated.

Concretely, the noise generating source 9 is an inverter. An object to which the noise generating source 9 is connected as to the power source lines 5a and 5b is the original power source 2, and that as to the power source lines 6a and 6b is the indoor unit 4, so that the objects are different from each other. As above said, an impedance difference usually occurs between the objects to which the outdoor unit 3 is connected.

In the indoor/outdoor lines Lin, the impedance in the power source lines 6a and 6b and the impedance in the signal line 7 are different from each other. When the lines 5a, 5b, 6a, 6b and 7 having different impedances are wound by the same number of turns, the magnetic field generated in the magnetic body 22 does not become uniform in the lines 5a, 5b, 6a, 6b and 7, and the noises 12 and 13 are canceled in off balance. Consequently, the number of turns of each of the lines 5a, 5b, 6a, 6b and 7 is set in consideration of the ratio of the impedances so that the influence on the

magnetic field generated in the common magnetic body 22 becomes almost uniform.

Theoretically, since the noises 12 and 13 come from the same noise generating source 9, the larger the impedance of each of the wound lines 5a, 5b, 6a, 6b and 7 is, the smaller the magnetic field generated in the magnetic body 22 by the lines 5a, 5b, 6a, 6b and 7 becomes. For example, as shown in FIG. 3, when it is assumed that a current flowing between the power source lines 5a and 5b is I1, a current flowing between the power source lines 6a and 6b is I2, the total number of turns of the power source lines 5a and 5b is N1, and the total number of turns of the power source lines 6a and 6b is N2, if the influence on the magnetic fields of the power source lines 5a and 5b and the power source lines 6a and 6b is made uniform, theoretically, the following equation (1) is satisfied.

$$N1 \times I1 = N2 \times I2 \ldots (1)$$

When the voltage level of each of the noises 12 and 13 which occur in the power source lines 5a and 5b and the power source lines 6a and 6b is V, an impedance between the power source lines 5a and 5b is Z1, and an impedance between the power source lines 6a and 6b is Z2, the Ohm's law of the following equations (2) and (3) is satisfied.

$$I1 = V/Z1 \ldots (2)$$

$$I2 = V/Z2 \ldots (3)$$

From the equations (1) to (3), the following equation (4) can be derived.

$$N1/Z1 = N2/Z2 \ldots (4)$$

The relations are applied to all of the lines 5a, 5b, 6a, 6b and 7.

Therefore, when the number of turns of the lines 5a, 5b, 6a, 6b and 7 of a relatively high impedance is set to be proportionally large, in theory, the influence on the magnetic fields of the lines 5a, 5b, 6a, 6b and 7 can be made uniform and the noises 12 and 13 can be properly canceled out. Concretely, the impedance of the lines 6a, 6b and 7 of the indoor/outdoor lines Lin connected to the indoor unit 4 is higher than that of the power source lines 5a and 5b connected to the original power source 2. Therefore, the number of turns of each of the lines 6a, 6b and 7 of the indoor/outdoor lines Lin is set to be larger than that of the power source lines 5a and 5b connected to the original power source 2. In practice, however, there is a case such that the degree of noise elimination varies due to a factor other than the above-described theory, such as resonance of noise by an influence of other peripheral parts or the like. Consequently, it is desirable to set the number of turns of each of the lines 5a, 5b, 6a, 6b and 7 on the basis of actual measurement values of the degree of noise elimination while making the influences on the magnetic field of the lines 5a, 5b, 6a, 6b and 7 uniform by using the relation of the equation 4 as a foundation. In this case as well, the impedances and the number of turns of the lines 5a, 5b, 6a, 6b and 7 are set so as to be almost proportional to each other.

In such a manner, when the noises 12 and 13 are transmitted from the noise generating source 9 to the lines 5a, 5b, 6a, 6b and 7, the lines 5a, 5b, 6a, 6b and 7 are wound around the common magnetic body 22 and the noises 12 and 13 transmitted over the lines 5a, 5b, 6a, 6b and 7 are canceled out each other with back electromotive forces generated in the lines 5a, 5b, 6a, 6b and 7. Thus, the noises 12 and 13 can be efficiently eliminated.

Since the number of turns of each of the lines 5a, 5b, 6a, 6b and 7 is set so as to make the influences exerted on the magnetic fields of the lines 5a, 5b, 6a, 6b and 7 uniform, at the time of efficiently eliminating the noises 12 and 13 by making the noises 12 and 13 transmitted over the lines 5a, 5b, 6a, 6b and 7 cancel out each other, the noises 12 and 13 can be prevented from canceling out excessively or insufficiently.

Although the number of turns of each of the three lines 6a, 6b and 7 of the indoor/outdoor lines Lin is set individually on the basis of the impedance of each of the lines in the foregoing embodiment, the number of turns of the indoor/outdoor lines Lin as a bundle of electric lines may be set in consideration of a total single impedance in a parallel circuit of the lines 6a, 6b and 7 of the indoor/outdoor lines Lin as a bundle of electric lines. In this case, the number of turns of each of the lines 6a, 6b and 7 of the indoor/outdoor lines Lin is the same.

While the invention has been shown and described in detail, the foregoing description is in all aspects illustrative and not restrictive. It is therefore understood that numerous modifications and variations can be devised without departing from the scope of the invention.